

MPEG Confidence Testing Using the AD920



▶ Check MPEG Streams With Confidence

In order to verify correct system operation, service engineers need to check a variety of parameters when installing and maintaining MPEG systems. What they need is a light-weight, easy-to-carry instrument that can quickly make these tests with confidence. This need is met by the Tektronix AD920 confidence tester which ensures the health of your transport stream.

Handheld Confidence Tester Provides First Line of Defense

The rollout of digital video services has created a rapidly growing need for easy to use installation and maintenance measurement tools designed specifically for digital video applications. As the market leader in MPEG-2 compressed digital video test and measurement, Tektronix addresses this need with the AD920 – a handheld confidence tester that provides a first line of defense for analyzing MPEG-2 transport stream formats.

Confidence testing is the ability to quickly perform a set of critical measurements that will identify quality and reliability problems in digital video traffic. As such, confidence testing is distinguished from diagnostic testing – which entails more comprehensive measurements in order to diagnose quality, reliability, and efficiency problems – and

characterization testing – which entails even more comprehensive measurements used for device and system characterizations.

Ideal for simple error checking, the AD920 confidence tester monitors MPEG-2, DVB, and ATSC streams via ASI (Asynchronous Serial Interface) and SMPTE310 (Society of Motion Picture and Television Engineers standard 310M) interfaces in real time. It provides graphical indication of stream-associated rates, and counts errors as defined in TR 101 290 (formerly ETR290) first priority testing. In addition, a log of errors is maintained on-screen, giving the user historical readouts of stream-associated errors.

Lightweight and portable, the AD920 also minimizes initial investments by reducing installation and maintenance time, and improving fault diagnosis and stream conformance testing. In most cases, it will give enough information to eliminate the need to use less portable diagnostic testers.

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Critical Elements of an MPEG Stream

The critical elements within an MPEG transport stream are the building blocks on which the MPEG stream is built. If any one of these elements fails, decoding will typically cease, resulting in a total loss of sound and picture.

The Digital Video Broadcasting (DVB) Project defines these critical building blocks as First Priority elements in TR 101 290 – Measurement Guidelines for DVB Systems. These guidelines can be largely applied to ATSC as well as DVB systems and are primarily designed to check the integrity of an MPEG-2 transport stream in an operational environment. The aim of these tests is to provide a “health check” of the most important – 1st priority – elements. It is worth noting that full quality of service cannot be realistically achieved unless TR 101 290 2nd and 3rd priority functions are also correct.

The 1st Priority elements of an MPEG-2 transport stream are the set of parameters necessary to ensure that the transport stream can be decoded. They include:

- ▶ **TS_sync_loss** – Synchronization depends on the number of correct sync bytes needed for the device to synchronize and the number of distorted sync bytes the device cannot handle. If the AD920 detects two or more consecutive distorted or corrupted sync bytes, a TS_sync_loss will be indicated.
- ▶ **Sync_byte_error** – The sync byte is used throughout the channel encoder and decoder chains for synchronization. It is important that every sync byte be checked for correctness since the encoders may not necessarily check the sync byte. The AD920's sync_byte_error indicator is set if the correct sync byte (0x47) does not appear after 188 or 204 bytes (as recommended by TR 101 290).
- ▶ **PAT_error** – The Program Association Table (PAT), which only appears in PID 0x0000 packets, tells the decoder what programs are in the transport

stream and points to the Program Map Tables (PMT), which in turn point to the component video, audio, and data streams that make up the program. If the PAT is missing, the decoder cannot function and no program is decodable. The AD920 indicates a PAT_error for any of the following reasons:

- if a PID 0x0000 packet does not occur at least every 0.5 s
- if a PID 0x0000 packet does not contain a table_id 0x00 (i.e., a PAT)
- if Scrambling_control_field is not 00 for a PID 0x0000 packet

- ▶ **Continuity_count_error** – For this indicator, three checks are combined. These are:

- incorrect packet order
- lost packet
- a packet occurs more than twice

Incorrect packet order and lost packet can cause problems for IRDs (Integrated Receiver Decoders) that are not equipped with additional buffer storage and intelligence. These two tests are logically OR-ed together with the third test (multiple packets) into one indicator.

- ▶ **PMT_error** – The PAT tells the decoder how many programs there are in the stream and points to the PMTs that contain information about where parts (video, audio, and data streams) of any given event can be found. Without a PMT, the corresponding program is not decodable. The AD920 indicates a PMT error for the following two reasons:
 - Sections with table_id 0x02 (i.e., a PMT) do not occur at least every 0.5 s on the program identifier, or PID, that is referred to in the PAT
 - Scrambling_control_field is not 00 for all PIDs containing sections with table_id 0x02 (i.e., a PMT)
- ▶ **PID_error** – The AD920 will indicate a PID_error whenever a referred PID does not occur for a user-specified period.

In addition to these critical First Priority measurements, the AD920 performs several other measurements that should be made in order to successfully test for confidence. These include:

- ▶ 27 MHz master clock rate
- ▶ Signal level
- ▶ Transport rate
- ▶ Data rate
- ▶ Packet size

These measurements provide confidence, at the physical level, that the signal source corresponds to what is being tested. For example, if a stream filled with null packets maintains all aspects of the MPEG-2 architecture, the result is “no content.” By testing Data Rate and Transport Rate, then subtracting the data rate from the transport rate, the user can determine exactly how much of the data stream is made up of null packets.

Measuring signal level gives the engineer confidence that cable length has not brought the signal too close to its physical limit for equipment downstream. To test this scenario, the loop-through can be used to bring signal level back up to 800 mV_{p-p}. The Packet Size measurement provides an indication of the physical format of the packet (excluding or including Reed Solomon code) for downstream equipment set-up.

Every MPEG stream contains provisions for inserting a user-defined stream ID in the PAT. The AD920 is able to detect and display this Stream ID. The Stream ID assures the engineer that the correct stream is being detected and is particularly useful for identifying individual streams in a bank of cables that have no identification.

Together, the previous tests provide confidence that you have a stream that is compliant with MPEG-2 architecture and equally applicable to DVB and ATSC standards.

Interfaces and Standards

The AD920 has been designed to accept the two main interface types found in broadcast installations world wide – ASI and SMPTE310M. Both systems work with coaxial-to-BNC connection types and run at 19.34 Mb/s (8VSB – SMPTE310M) and 270 Mb/s (ASI). Signal level is 800 mV_{p-p} ±10% (into 75Ω) in both cases.

AD920 is primarily an MPEG-2 test device, and as such will work across any MPEG-2 based standard including DVB, ATSC, and most ISDB transport streams.¹

¹ Sync Loss problems will be observed with ISDB-S streams whereby some sync bytes (0x47) are overwritten with control information.

MPEG Confidence Testing

▶ Application Note

The Graphic Interface

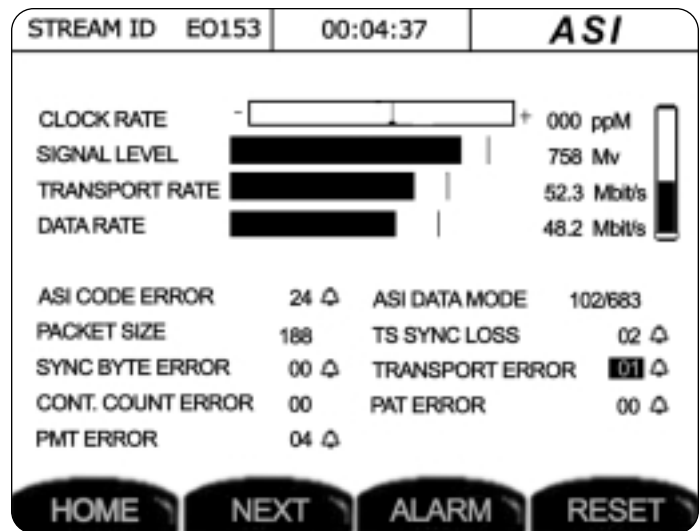
Over several years, we have perfected the ability to run the TR 101 290 First Priority test suite from a single device. These tests run with absolute stability and reliability throughout the life of the unit. Measurement results are displayed on an integral LCD display panel (see Figure 1). Linear measurements such as Clock Rate, Signal Level, Transport Rate, and Data Rate are displayed as graphical bar graphs accompanied by a digital numerical readout for exact values.

Conditional measurements such as Sync_byte_error and Continuity_count_error are correct or incorrect (pass/fail), depending upon whether or not they comply with TR 101 290 guidelines. These parameters are displayed on screen whenever a condition is not fulfilled. Error counts are provided, helping the user build an accurate assessment of a particular stream's error status. Using the real-time clock displayed, more formalized quantitative conclusions can be formed.

Installation Test

When installing MPEG-2 equipment for cable, satellite, and terrestrial transmissions, service engineers need to perform specific tests to ensure that the streams are operating appropriately. With the AD920, users can test for the following:

- ▶ Physical electrical connection at interface
 - Testing the physical electrical level at the interface during installation is critical to ensuring overall stability. It prevents catastrophic failure due to hazards as simple as incorrect signal levels. By checking signal level during installation, proprietary and client systems are far more likely to give continuous trouble-free operation over time as new cables are added or the original architecture changes.



▶ **Figure 1.** Measurements provided by the AD920. Results are displayed in an easy-to-read bar graph format.

- ▶ Bit rate indicates actual data is being sent
 - The presence of a transport stream is no guarantee that data is actually being sent and received. By indicating data presence, the AD920 provides users with confidence that a valid transport stream exists.
- ▶ Sync indicates cable stability – no breaks or loose connections
 - Sync loss is often a symptom of bad wiring or connections further up stream. By testing for Sync loss with the AD920, an engineer can be confident physical cabling is less likely to cause an error.
- ▶ PMT/PAT indicate content is correct or incorrect from the MUX
 - Both PMT and PAT are essential components for decoding a transport stream. When multiple video, audio, and data streams are multiplexed together, both PMT and PAT are created. Testing both for correctness assures the engineer the multiplex has been performed correctly and that the transport stream is critically decodable.

- ▶ Stream ID identifies streams and composition and ensures that ASI routing is correct from hub
 - During installation, many cables are routed around a building through walls, ducts, and cable trays. Consequently, it is often hard to isolate a given feed, stream, or circuit. The Stream ID extracted and displayed on the AD920 enables installation teams to quickly identify content, allowing them to lay wires, connect sources, and isolate cables simply for connection to other equipment.
- ▶ HDTV 60 Mb/s + contribution link compatible
 - The AD920 is fully compatible with ATSC HDTV signals, up to a maximum of 100 Mb/s. This exceeds normal levels of usage, which are between 40 and 60 Mb/s. The ability to test up to 100 Mb/s assures that the AD920 will be usable as data rates increase with possible bandwidth expansion.

Field/System Maintenance

When maintaining MPEG-2 streams for cable, satellite, and terrestrial transmissions, service engineers need to perform specific tests to quickly identify and predict system problems. With the AD920, users will test for the following:

- ▶ Troubleshooting
 - The lightweight, rugged AD920 is the ideal tool for troubleshooting your system in the field. The AD920 quickly isolates errors, permitting you to contain and control problems faster. The time saved helps to guarantee on-air time.
- ▶ Isolate faults at transport and physical levels
 - Because the AD920 tests both electrical and transport level conditions, fault isolation is even easier.
- ▶ Routine maintenance/checking tool
 - In order to protect against failure, the broadcast infrastructure should be checked on a regular basis in order to identify faults before they occur.

Often, equipment running close to its physical limits will show no sign of potential failure until it suddenly stops working; this effect is known as the digital cliff. By performing routine maintenance and checking with the AD920, potential problems can be foreseen and time and money can be saved.

- ▶ Disaster recovery
 - In order to provide quality of service, broadcasters need to assess possible unanticipated downtime situations and plan solutions for quickly resolving them. Pre-planning saves time, money, and energy when a problem does arise. AD920 forms a perfect first line of defense in such situations. Because the AD920 is value priced, multiple units can be deployed along the transmission chain or placed with individual engineers. In the event of a catastrophic failure, the AD920 enables rapid re-routing, fault finding, and confidence testing.
- ▶ Contribution fault isolation
 - Errors outside of your direct control can be particularly frustrating, especially when you need to confirm the fault is, or is not, within your infrastructure. A fault within a stream could originate with a supplier in the form of a contribution feed. Rather than spend what can become a significant amount of time attempting to apportion blame for the fault, the AD920 allows a user at either end to rapidly determine the point of origin.
- ▶ HDTV 60 Mb/s + contribution link compatible
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Table 1. MPEG-2 System Errors

Error	Causes	Effect on decode	Action
Sync loss	Transport stream not present at the input to AD920	The screen will either turn black or freeze frame	Check cabling
Sync byte error	Bit errors in the transport stream	Dependent upon frequency, the screen may freeze intermittently or cause blockiness	Check cabling
Continuity count error	Missing packets or incorrectly generated continuity counts	The vast majority of decoders are likely to either freeze or cause a blank screen	If the incoming transport stream has been through a switched network, this indicates a network failure; otherwise the multiplexer or re-multiplexer is faulty
PMT error	PMT error may be raised due to the absence of a PMT or the repetition rate falling outside the limit set by the DVB of 0.5 s	The decoder will not be able to locate a channel, or channels	Multiplexer or re-multiplexer is at fault
PAT error	PAT error may be raised due to the absence of a PAT or the repetition rate falling outside the limit set by the DVB of 0.5 s	The decoder will not be able to locate any channel	Multiplexer or re-multiplexer is at fault
ASI code error	Recovered hotlink characters are invalid	Loss of signal as sync loss, or dependent upon frequency, intermittent loss	Connect to an ASI feed (the unit may be connected to an SDI feed or an analog feed)
Transport error	A transport error indicates that the transport stream contains uncorrectable errors	Undecodable stream. Possible freeze frame or blank screen	The transmission chain is suffering from degradation

Possible Errors, Causes, Effects, and Corrective Actions

Because of the nature of MPEG transport streams and the way they are decoded, it is difficult to accurately predict the effect an error may have on decode. The effect depends upon when in the stream the error or errors occur and the resilience of your decoder or the end user's decoder.

Table 1 identifies some errors that occur in MPEG-2 systems, possible causes for those errors, the effect those errors have on decode, and actions that can be taken to correct those errors. There may be reasons for each error other than those listed and other corrective actions that can be taken, but the suggested actions in Table 1 are a good starting point.

AD920 - The Only Choice for Reliable, Cost-effective Confidence Testing

The AD920 provides better quality of service by reducing installation time, minimizing downtime, and giving engineers and technicians the ability to quickly identify faults, all of which reduce operating costs and eliminate expenses associated with being off-air or missing installation deadlines.

The AD920 is a cost-effective signal test solution for compliance testing and confidence checking to all standards (MPEG-2, DVB, and ATSC). It includes built in TR 101 290 Priority 1 measurements, giving users an industry-standard test suite at their fingertips.

Transport stream error status and Stream ID are available at a glance; together they enable rapid identification of problems associated with specific feeds. Data rate, transport rate, clock rate, and signal level are all immediately available in bar-graph format, giving the user graphical representations of these key test parameters.

Portable and battery powered, the AD920 allows the user to move around a site without the need for power sockets. With an intuitive user interface and a selectable audible alarm, the AD920 allows the user to quickly set internal alarms for any or all included tests. Additionally, a continuously-accumulating error log indicates error issues over time.

The AD920 is easy to use in a variety of applications. Field service engineers can use the AD920 to isolate issues within their systems. Maintenance engineers can use the AD920 for reporting errors without needing prior MPEG knowledge. System integrators can use the AD920 during installation for quick confidence monitoring and to isolate a given feed using built in transport stream identification.

Tektronix provides support anywhere in the world, either locally or online. As the market leader in MPEG-2 compressed digital video test and measurement, Tektronix has a proven record of producing superior equipment that gives you the results you need.

MPEG Confidence Testing

▶ Application Note



AD953 and MTS300 MPEG Test Systems

- ▶ Powerful real-time monitoring and analysis of MPEG/DVB/ATSC/ISDB transport streams
- ▶ In-depth, off-line analysis of transport, program, and elementary streams
- ▶ MPEG transport stream recording and playout



AD920 MPEG Handheld Tester

- ▶ Self-contained, handheld and battery-operated; ideally suited for field use
- ▶ SMPTE 310M and ASI interfaces
- ▶ Easy to use and easy to learn



AD954 MPEG Portable Analyzer

- ▶ MPEG-2/DVB/ATSC transport stream support
- ▶ Detailed off-line transport stream analysis
- ▶ Light and portable, ideally suited for in-field diagnosis



WFM90 Handheld Waveform Monitor

- ▶ Self-contained unit with integrated color LCD display
- ▶ NTSC or PAL capable, suited for troubleshooting and equipment installation
- ▶ Multifunction capabilities powerful enough to set up and troubleshoot complex systems

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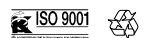
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Updated October 30, 2001

For Further Information

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